

Technological Innovations for the Arctic and the Far North: Areas of Patenting Intellectual Property

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Abstract

The analysis showed that with a significant amount of research on the problems of the Arctic and the Far North, they do not pay enough attention to the formation and implementation of technological innovations for these territories - patentable intellectual property objects. In this regard, in this work, we performed a patent information search and analyzed inventions and utility models for the conditions of the territories of the Arctic and the Far North. On this basis, the features of these inventions and utility models are shown, the main areas of patenting in the analyzed area, universities and organizations that form and patent their developments aimed at solving acute technological and technical problems of the Arctic and the Far North are determined. Formed knowledge base on Russian patents for inventions and utility models for the Arctic and the Far North, which can be used by researchers, developers and manufacturers in the selection of analogues and prototypes in the development and patenting of new intellectual property.

Keywords: Arctic, Far North, innovation, intellectual property, artificial intelligence, patent, patent information search.

1. INTRODUCTION

The possibility of solving the socio-economic problems of Russia substantially depends on the development of the economy of the territories of the Arctic and the North of Russia. We believe that the opinion expressed in [1] is that the most important factors for the effective use of the potential of the Arctic and the Far North are promising not only the extraction and processing of raw materials in these territories, the maintenance of the population living and working in these territories, but also the production of goods and services based on intellectual property (add - and the production of intellectual property itself). However, studies have shown that in the known works practically no attention is paid to the consideration of innovative technological and technical solutions, protected by patents for inventions and utility models. This necessitates an analysis of the state of scientific research and areas of

development of new intellectual property, patenting of inventions and utility models for the Arctic and the Far North.

The rapid development of multidimensional research in the Arctic is caused by its multidimensional growing global and competitive potential, according to which the development of its territories for Russia is currently one of the most important directions in the development of its mineral and natural resources, strengthening the country's fuel and energy complex. It is no accident that at the beginning of the XXI century many foreign countries (Denmark, Canada, Iceland, Norway, the USA, Finland, Sweden, China, India) and their corporations developed strategies for the development of the Arctic zones [2; 3].

It is known that the territories of the Arctic and the Far North at the present stage of development are important for meeting the needs of many countries in natural resources. These territories, according to [4; 5] provide 100% of the need for apatite concentrate, 40% ... 100% of the reserves of gold, oil, natural gas, chromium and manganese, platinum and diamonds are concentrated in these territories. However, the development of Arctic resources is associated with the need to overcome challenges arising from harsh environmental and climatic conditions, seasonality of work, a low degree of geological exploration, fluctuations in weather conditions affecting the state of oil platforms under the influence of waves, icing, collisions with icebergs, etc [6].

According to the innovative scenario for the development of the Arctic considered in [11], its characteristic features will be: a) realization of competitive advantages in the form of natural resource potential; b) the manifestation of a new quality of economic growth, based on the use of advanced technologies in various sectors of the economy, the development of the information and communication complex. The implementation of the scenario should be aimed at transforming the institutional environment, modernizing the service, industrial, energy infrastructure, creating deep processing plants for producing products with high added value, introducing technological and organizational innovations, developing universities that

produce knowledge that is competitive in the world market.

A number of works investigate the formation of unmanned remote automated environmental monitoring systems in the Arctic using satellite and sonar systems, and robotic means. In research provided by Vaulin Yu.V., Inzartsev A.V., Kamorny A.V. et al. (2008) [7], the experience of creating and using an integrated navigation system of an autonomous underwater robot for complex conditions of the Arctic when working under ice is considered.

In a whole series of well-known works, serious attention is paid to the study of the specifics of people living and working in the difficult natural and industrial conditions of the Arctic and the Far North, the physiology of labor in these conditions, medical care, selection of people, their social well-being. Attention to these issues is caused by the influence of the state of health and adaptation of the able-bodied population in the Arctic region on the success of solving the problem of developing and using the natural resources of the Arctic and the Far North.

In research provided by Syurin S.A. and Kovshov A.A. (2019) [8], it is noted that a significant number of employees at enterprises in the Arctic zones of Russia are exposed to hazardous and harmful production factors. In the papers [9; 10] it is noted that the main contribution to the structure of primary morbidity, especially of the Arctic children's population, is made by respiratory diseases, which occurs under the influence of harsh climatic conditions and the presence of certain persistent pollutants with immunosuppressive effects.

In research provided by Zaykov K.S., Kalinina M.R., Kondratov N.A. and Tamitsky A.M. (2016) it is noted that the accent of the Arctic strategies of many states provides for the solution of environmental management issues in the Arctic environment through the development of alternative energy; development of biological and mineral resources; conservation of biodiversity, support of indigenous peoples; the use of Arctic shelf deposits in compliance with high environmental standards

In recent years, research has been developing in the field of environmental aspects arising from the industrial development of the Arctic and the Far North, including pollution of local ecosystems. Studies of the problems of ensuring the stability and restoration of land cover in the Arctic are considered in the works.

In research provided by Stepanko N.G. (2019) [12], the need is noted in the territories under consideration for implementing measures to strengthen the environmental direction, including the restoration and "rehabilitation" of territories subject to anthropogenic impact (the reclamation of their cleared lands from production waste and unauthorized landfills); implementation of environmental and resource-saving projects; directions; creation of new and reconstruction of old water supply, sanitation, disposal or recycling systems of solid waste.

We believe that the opinion expressed in [1] is consistent with our position and that the most important factors for the effective use of the potential of the Arctic and the Far North are not only the extraction and processing of raw materials from these territories, the services of the population living and working in these territories, but and the production of goods and services based on intellectual property (add - and the production of

intellectual property itself).

Thus, it can be stated that in the considered works practically no attention is paid to the consideration of innovative technological and technical solutions, protected by patents for inventions and utility models. This leads to research aimed at analyzing the state of scientific research and areas of development of new intellectual property, patenting inventions and utility models for the Arctic and the Far North.

2. MATERIALS AND METHODS

The purpose of this work is to analyze the state of scientific research in the development of the territories of the Arctic and the Far North, the problems and challenges that arise in this case, and to identify areas for developing new intellectual property, patenting inventions and utility models for the Arctic and the Far North.

According to the methodology of work, at the first stage of the work it was envisaged to study the features of the territories of the Arctic and the Far North as objects of research. Moreover, studies performed in recent years are considered as used materials. To achieve this goal, the materials of information-analytical search were studied, reviewed and used.

At the second stage of the work, the results of an extended patent information search were used as research materials, in which the knowledge base of the Russian Science Citation Index and the Federal Institute of Industrial Property were widely used.

At this stage of the work, the methodology provided for the formation and analysis of a knowledge base in the field of research on patents for inventions and utility models patented in Russia in 2015-2019. An analysis of the features of technological and technical solutions laid down in these inventions and utility models was provided.

The task was to pay special attention to patented solutions for remote monitoring and control, as well as to create technological and technical systems that ensure functioning in the uninhabited conditions of the Arctic and the Far North, based on the use of artificial intelligence, as well as solutions aimed at solving the problems of the population, living and working in the difficult climatic conditions of the Arctic and the Far North.

The research objectives included:

- determination of the main directions of patenting of intellectual property in Russia in the field of development of new intellectual property in the domestic and foreign markets;
- identification of universities, scientific organizations, other business entities and private individuals patenting intellectual property objects that they develop;
- creating a knowledge base about Russian patents for inventions and utility models in the field of developing new technological and technical solutions for the Arctic and the Far North for use by researchers, developers and manufacturers to select analogues and prototypes for the development and patenting of new intellectual property.

3. RESULTS AND DISCUSSION

According to the research methodology, the features of technological and technical solutions patented in Russia in 2015-2019 for use in the Arctic and the High North that are patented in Russia and the directions for patenting these solutions by universities, organizations, business entities and individual authors are described below.

The method using artificial intelligence of seismic monitoring of the formation of technogenic hydrocarbon deposits during exploration and development of fields in the Arctic and other seas was patented by Gazprom Dobycha Yamburg LLC [13]. The method is aimed at ensuring control and improving the safety of hydrocarbon deposits with placement at the bottom of the water area above the field one or more stationary seismic streamers, registration of seismic traces, control of fluid substitution in the hydrocarbon field and the environment her environment, the definition of spatial migration of hydrocarbon fluids and regulations emerging man-made reservoirs. The novelty of the method lies in the fact that seismic streamers are placed with a deepening below the bottom level to a depth exceeding the maximum possible level of examination by ice hummocks and hammers, and their removal from sources of elastic vibrations is set from the recording condition in the first arrivals of refracted waves from a seismic horizon located below the potential man-made deposits. The application of this method will allow you to quickly identify the moment of the beginning of the formation of man-made deposits and make appropriate management decisions on their liquidation at the minimum cost of permanently installed equipment.

A group of authors Polevoy D.V., Usilin S.A., Putintsev N.M. and Savelyev B.I. (25.01.2017) [14] patented an artificial intelligence-based system for collecting and processing data from external indicators of the state of the environment when monitoring critical situations in the Arctic.

A group of authors Arlazarov V.V., Andreeva E.N., Krivtsov V.E. et al. (06.04.2017)[15] patented a system for monitoring the thickness of the snow-ice cover in the Arctic. The introduction of new modules has significantly improved the speed of monitoring the server database by localizing the addresses of database records by the identifiers of the names of the Arctic ice massifs.

The authors Arlazarov V.V., Andreeva E.N., Krivtsov V.E. et al. (06.04.2017) [16] patented the system of the geoinformation database of the snow-ice cover of the Arctic, in which the reliability and speed of the system are improved by eliminating manual procedures performed by the operator when monitoring the data entered into the system and comparing them with data previously entered into the geo-information database. The system for identifying detection objects during remote sensing of the snow-ice cover of the Arctic is protected by patent of the RF No. 169849 (Arlazov, Merkov, Pestryakova et al., 2017).

Avangard Open Joint-Stock Company has received a patent in the field of computer systems for remote control of navigation systems for remote automated monitoring of the atmosphere and ice in the Arctic [17]. The system provides the ability for remote automated environmental monitoring in large areas in

the Arctic and the rapid exchange of information between the control center and navigation systems. This is achieved through duplex radio communications using complex phase-shift signals, computers and spacecraft of the satellite communications system as repeaters.

The Institute of Oil and Gas Problems of the Russian Academy of Sciences for control during the development of hydrocarbon deposits in the Arctic patented a method of seismic monitoring [18]. With its help, the spatial migration of hydrocarbon fluids and the position of the emerging technogenic deposits are determined. In the monitoring system of soil and surface water in the oil and gas production area in the zone of oil and gas field development in the Far North, the method patented by Gazprom can be used [19].

The rescue icebreaker has been patented [20]. The technical solution of the rescue icebreaker will increase its technical and operational characteristics, as well as its efficiency during emergency rescue operations from offshore engineering facilities, primarily from offshore oil and gas production platforms in severe ice and weather and climate conditions in the Arctic.

Citecrim LLC patented a self-floating autonomous subsurface oceanographic buoy station that allows it to be lifted from the bottom of the water to the bottom edge of the ice, ice is drilled from bottom to top by means of an additional ice-bottom drilling tool, and communication antennas are inserted into the hole on the ice surface [21]. In the new design, the expanded functionality of the buoy station with drilling equipment for drilling ice from the bottom up, provides accurate vertical orientation by means of a special design of the float device, provides recharging of power elements during long-term operation. The removable tip of the drilling tool can be changed depending on the characteristics of the ice cover and the specified drilling conditions.

Conocophyllips Company (US) has patented in Russia [22] a self-elevating oil and gas drilling rig in potentially ice conditions. The second ice-class self-elevating drilling rig for oil and gas drilling in potentially ice conditions on coastal offshore areas was also patented by Conocophyllips Company (US), patented in Russia Noble, (Scheifer & Berta, 2016) Exxonmobil Upstream Research Company (US) patented an underwater production system hydrocarbons in the Arctic seas [23].

Ural-Siberian Industrial Company JSC has patented an Arctic-designed two-level environmentally friendly drilling rig [24]. The use of this installation will reduce the time of tripping operations, simplify and speed up the installation, maintenance and repair of equipment, which together allows saving significant funds for drilling wells in comparison with analogues. The use of an exhaust system with filters for purifying air from oil vapor in a drilling rig, as well as structural devices for collecting drilling fluid leaks, will minimize environmental pollution, that is, ensure environmentally friendly operation.

For use in structures and structures for various purposes in the Arctic and Antarctic, a method has been patented for the

production of a high-strength hot-rolled strip from corrosion-resistant steel with a low specific gravity, including obtaining a steel billet, heating, hot rolling of a billet, characterized in that the billet is made of steel [25]. Also, a method for the production of sheet metal for use in critical parts of automobiles, agricultural equipment, crane construction, etc. was patented; steel can be used in troitelnyh constructions in Siberia and Far North [26].

The authors believe that in the manufacture of various types of products for use in the Arctic and the Far North, high-strength nodular cast iron can be used [27; 28].

For use in the heat supply systems of vital objects in the development of the Arctic and the continental shelf, Omsk State University of Railway Engineering has proposed and patented a device for heating a liquid coolant [29]. In the tank for the heated fluid around the side surface of the inductor is made of a metal lattice of cylindrical shape, mounted coaxially with the inductor. The device allows to reduce the dispersion of thermal energy into the environment when heating a liquid coolant in heating systems and hot water supply of vital objects.

To extinguish fires at low temperatures characteristic of the Far North, the Arctic and the Northern Sea Route, Gazprom Dobycha Yamburg patented a foaming agent [30].

St. Petersburg Mining University has patented a sectional biogenic module for the integrated processing of organic waste in the Arctic [31]. The most effective mode of operation of the biogenic module is the one in which it is placed in a well-lit place, with a temperature not lower than -30°C .

Patents for developments in the field of environmental protection and restoration in the Far North are being patented. For example, Gazprom Dobycha Yamburg LLC and Yamal District Technological Park have patented a method to prevent oil migration to underground waters from contaminated tundra soils by adding peat to the contaminated areas and mixing it with soil [32].

The Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences has patented a way to improve the diet of dairy cows in the Far North [33]. The method includes the introduction into the main diet of animals of a biologically active additive in the form of a dry mass of leaves of Crowned Serpentina containing 20-hydroxyecdysone. In the Arctic, the phytosystem module patented by the Institute of Industrial Ecology of the North Sciences can be used for biological treatment of industrial wastewater from mineral pollutants [34]. The utility model relates to the field of environmental protection, including in the Arctic, in particular, to the technology of phyto-purification of natural and anthropogenic water bodies or quarry sewage in settling ponds from various mineral pollutants.

To monitor the human condition in extreme weather and climate conditions, a mobile stand-alone device was patented in the name of Senkevich Yu.I. (2015) [35].

Based on the analysis, the following universities, scientific organizations, other business entities, as well as individual authors and groups of authors, patenting their developments for

use in the Arctic and in the Far North, were identified. Among them:

- St. Petersburg Mining University [36];
- Belgorod State National Research University [37];
- National Research Technological University "MISiS" [38];
- Omsk State Transport University [29];
- Institute for Oil and Gas Problems RAS [18];
- Institute of Petrochemical Synthesis named after A. V. Topchiev [39];
- Institute of Industrial Ecology of the North [34];
- Tomsk National Research Medical Center [40];
- Central Research Institute of Ferrous Metallurgy named after I.P. Bardin [26];
- Agrophysical Research Institute and Phytosphere LLC [29];
- Federal Research Center for the Comprehensive Study of the Arctic named after academician N. P. Laverov of the Russian Academy of Sciences [41];
- Krylov State Scientific Center [42];
- Central Research and Testing Institute of Engineering Troops [43];
- Komi Science Center [33];
- PJSC Gazprom [19];
- JSC "Center for shipbuilding technology and ship repair" [44];
- JSC "Engineering company "Vityaz" [45];
- Gazprom Dobycha Yamburg LLC [13];
- Gazprom Dobycha Yamburg LLC and Yamal District Technological Park [32];
- JSC "Ural-Siberian Industrial Company" [24];
- Conocophyllips Company (US) [22];
- ExxonMobil Upstream Research Company (US) [23];

Among the main areas of patenting of intellectual property from the considered in the work highlighted the development of technological solutions in the field of:

- environmental monitoring, seismic monitoring, assessment of raw material deposits, the presence and characteristics of ice coverings, etc., control of navigation systems, including using artificial intelligence;
- creation of marine vehicles: icebreakers, autonomous oceanographic buoy stations;
- creation of drifting stations;
- creation of drilling rigs;
- increase the efficiency of vehicles;

- cold-resistant special steels and rolled products;
- construction and laying of pipelines;
- waste processing and development of northern agriculture;
- environmental protection and medicine, including the diagnosis of people living and working in the Arctic and the North;
- creation of military fortifications.

The knowledge base on Russian patents for inventions and utility models for the Arctic and the Far North, formed according to the results of the research, can be used by researchers, developers and manufacturers in the selection of analogues and prototypes in the development and patenting of new intellectual property.

4. CONCLUSION

1. This work develops the authors' research in the field of forming knowledge bases for analyzing the status and development trends of technology and technology objects for the synthesis of patentable solutions.

2. The rapid development of multifaceted research in the Arctic is caused by its multifaceted growing global and competitive potential, according to which the development of its territories for Russia is currently one of the most important directions in the development of its mineral and natural resources, strengthening the country's fuel and energy complex. It is no accident that at the beginning of the 21st century many foreign countries (Denmark, Canada, Iceland, Norway, the USA, Finland, Sweden, China, India) and their corporations developed strategies for developing the Arctic zones.

3. According to the innovative scenario for the development of the Arctic considered in [3], its characteristic features will be: a) realization of competitive advantages in the form of natural resource potential; b) the manifestation of a new quality of economic growth, based on the use of advanced technologies in various sectors of the economy, the development of the information and communication complex. The implementation of the scenario should be aimed at transforming the institutional environment, modernizing the service, industrial, energy infrastructure, creating deep processing plants for producing products with high added value, introducing technological and organizational innovations, developing universities that produce knowledge that is competitive in the world market.

4. The work of Druzhinin P.V. and Potasheva O.V. (2019) rightly focuses on the need to intensify the interaction of the regions of the North with universities and scientific organizations, since currently the amount of funding for research and development per employee, even in the leading regions of the North, is several times lower than on average in Russia. Noting these facts, the authors cite data that in the north of Finland the universities of Oulu and Rovaniemi, Sweden in Luleå and Umeå, in Norway in Tromsø not only develop, but also demonstrate a high level of innovative development.

5. We believe that the opinion expressed in Druzhinin P.V. and Potasheva O.V. (2019) is consistent with our position and that

the most important factors for the effective use of the potential of the Arctic and the Far North are not only the extraction and processing of raw materials of these territories, the services of the population living and working in these territories, but also the production of goods and services based on intellectual property (add - and the production of intellectual property itself).

6. It can be stated that with a significant amount of analyzed work on the problems of the Arctic and the Far North, they do not pay enough attention to the consideration of innovative technological and technical solutions, protected by patents for inventions and utility models. This leads to research aimed at analyzing the state of scientific research and areas of development of new intellectual property, patenting inventions and utility models for the Arctic and the Far North.

7. Based on the analysis, the following universities, scientific organizations, other business entities, as well as individual authors and groups of authors, patenting their developments for use in the Arctic and in the Far North, were identified. It was revealed that patenting in Russia in the foreign sphere is carried out by foreign companies, as well as groups of authors and individual inventors.

8. Among the main areas of patenting of intellectual property, the development of technological solutions in the field of environmental monitoring, seismic monitoring, assessing the characteristics of raw material deposits, the presence and characteristics of ice coverings, etc., managing navigation systems, including using artificial intelligence; creation of transport ships, icebreakers, autonomous oceanographic buoy stations; creating drifting stations; development of technological and technical solutions in the field of drilling rigs; increase the efficiency of vehicles; creation of cold-resistant special steels and rolled products; construction and laying of pipelines; waste management and development of northern agriculture; environmental protection and medicine, including diagnostics, for people living and working in the Arctic and the North; creation of military fortifications.

9. Many patented solutions based on the use of artificial intelligence are suitable for remote monitoring and control in the Arctic and the Far North, as well as for the creation of technological and technical systems that ensure functioning in the uninhabited conditions of the Arctic and the Far North.

10. The knowledge base on Russian patents for inventions and utility models for the Arctic and the Far North, which can be used by researchers, developers and manufacturers when choosing analogues and prototypes when developing and patenting new intellectual property objects, formed according to the results of the research.

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